UCRL-CONF-203605

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Lawrence Livermore National Laboratory
Livermore, CA, USA 94550

Abstract

The targets used in the Hot Halfraum Campaign at OMEGA create many hot electrons, which result in a large flux of hard x-rays. The hard x-rays produce a high background in the streak camera. The background was significantly reduced by wrapping the streak camera with a high-Z material; in this case, 1/8" of Pb. The large hard x-ray flux also adds noise to images from framing cameras which use CCDs.

The Hot Halfraum experiments at OMEGA[1] put ~9.5kJ of 351nm laser energy into small halfraums (half cylinders) in a 1 nS square pulse. Most targets create a large amount of hot electrons. The hot electrons deposit their energy in the halfraum's gold wall, and this energy is converted into hard x-rays (energies >50 keV)[2]. The hard x-ray flux is measured in the four-channel HXRD[3] detector at OMEGA. It was discovered that when the hard x-ray flux is high, the image from the x-ray streak camera has a very high background over most of its area. The hard x-ray flux is defined as "high" when the PEAK voltage in HXRD 2 and HXRD 3 is 200 Volts or more. It was found necessary to shield the streak camera from both direct and indirect hard x-rays to reduce the background (Figure 1).

In these experiments, the streak camera, SSC-1, is fielded with the MS-SXI snout, a soft x-ray snout consisting of a 3^{o} Pt mirror and a ~10um-thick Mg filter (see

Figure 2). The snout is made of aluminum. The Mg filter is at the interface between the snout and streak camera. The Mg would absorb the aluminum fluorescence. A series of slits block the streak camera's photocathode from having a direct view of the target.

The initial configuration had no additional shielding beyond MS-SXI's slits. . A 250um brass slit was used in the streak camera. The background in the streak camera was high, so shielding was gradually increased. Figure 3 shows the streak camera images as a function of shielding. For the second configuration, 1/2" Pb was placed in the MS-SXI snout to block direct hard x-rays, and a Ta slit was used in the streak camera. This combination did reduce the background by a small amount. In the third configuration, 1/2" Cu was added between the two 1/4" Pb slabs. The Cu absorbs the Pb flurescence. It is unclear if this reduces the background more than just 1/2" Pb. In the fourth configuration, all this shielding was kept and the streak camera was wrapped in 1/8" thick Pb, as shown in Figure 1. This dramatically reduces the background level.

DISCUSSION:

The hypothesis for the reduced background with the Pb-wrap is the following: the hard x-rays interact with materials around the streak camera; these materials fluoresce and scatter. Some of the scattered x-rays penetrate the wall of the streak camera in the drift tube region. The drift-tube area is between the focusing aperture and phosphor. There are no optical baffles here, so these x-rays can bounce around the drift tube region, producing fluorescent x-rays, which excit the phosphor, resulting in the high background. The Pb-wrapping absorbed much of the x-rays that otherwise would scatter into the drift tube region from the side.

We have not tested the Pb-wrapped streak camera without the Pb or Pb/Cu direct shielding, but comparing the first two images in Figure 3, we conjecture that this shielding is probably necessary.

We note that the focusing aperture in the streak camera is made of aluminum not tantalum.

FRAMING CAMERAS and CCDs

Hot Halfraum experiments use framing cameras (XRFCs and FXI-1) with a soft x-ray snout (SXR)[4] similar to the MS-SXI. The pinholes are in 10 mil Ta to shield against hard x-rays. This is sufficient to reduce the hard x-ray background for our experiments, although detected hard x-ryas ARE visible on the strips. For those shots which produce many hot electrons, the CCD images have randomly saturated pixels and lines (Figure 4).

We thank Greg Pien and Jack Armstrong for their help in fielding this at OMEGA.

**Work performed under the auspices of the U.S. Department of Energy by the University of California Lawrence Livermore National Laboratory under Contract No. W-7405-ENG-48.

References:

1. http://www.lle.rochester.edu/05_nluf/index.html (to download User manual)

2. J. Lindl, Physics of Plasmas, **2**, 11 (1995)

3. C. Stoeckl *et al.*, Rev. Sci. Instrum. **72**, 1197 (2001)

4. F. Ze *et al.*, Rev. Sci. Instrum **63**, 5124 (1992)

Figure Captions

Figure 1: Schematic diagram and picture of the shielding around streak camera SSC-1. Sheets of 1/16” Pb are wrapped around twice. There was some concern about letting the streak tube and cathode breathe, which is why the wrap is done in two pieces outside of the existing μ-metal shield. There is a piece around the streak tube, and a wrap around the intensifier package

Figure 2: The MS-SXI snout showing the shielding. The snout has a 3^o Platinum mirror with a 10um Mg filter near the streak camera’s photocathode (PC). The photocathode has no direct view of Target Chamber Center (TCC). Initially, there was no filtering in the dotted box near the mirror, but later, a 1/2” Pb slab, and then, a 1/4” Pb : 1/2” Cu : 1/4” Pb slab was positioned there to block the direct hard x-rays. The MS-SXI snout is made of aluminum.

Figure 3 (a) Diagram showing the MS-SXI view of the halfraum at 79^O to the back wall. The small diagnostic hole in the back wall produces a weak signal when the 1nS drive beams turn on. At t=1.2nS, a fiducial beam hits the outside wall of the halfraum, producing a strong soft x-ray signal.
(b),(c),(d) (e) Data as a function of shielding conditions. (left) MS-SXI streaked exposure images. The 1 ns drive turns on at t=0, and the fiducial beam hits the side wall at t=1.2nS. (center) Horizontal lineout (intensity vs. time) through the center of the signal of the fiducial beam. (right) HXRD 2,3 voltages vs. time. These are all quite similar for the four cases, showing the hard x-ray fluxes were similar, so the reduction in background is due to the added shielding. In (d),(e) the eight UV timing fiducial pulses spaced 0.548 nS are visible.

Figure 4: The two images are taken at the same time with soft x-ray (SXR) snouts on framing cameras, and 10 mil Ta substrate for pinholes. The CCD image has random pixel noise and vertical lines.

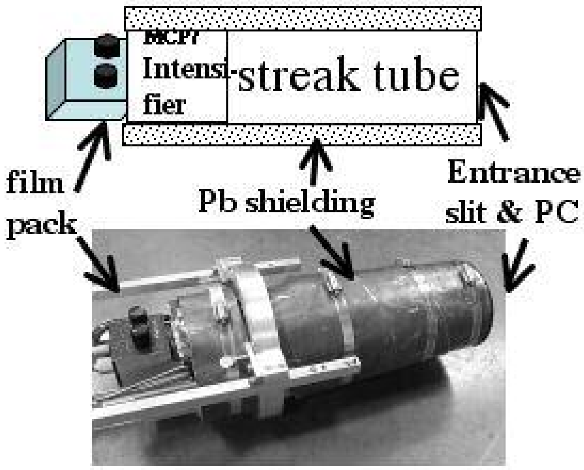

MCPI
Intensi-
fier
streak tube
film
pack
Pb shielding
Entrance
slit & PC

Figure 1

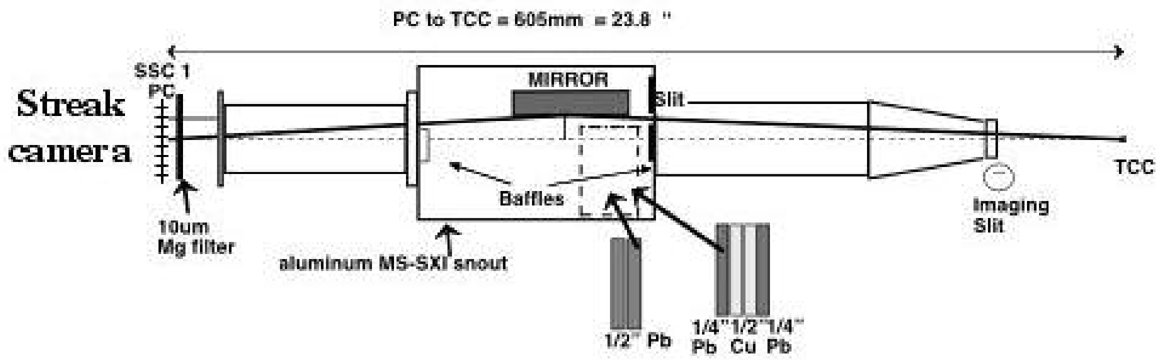

PC to TCC = 605mm = 23.8 "
SSC 1
PC
Streak
camera
MIRROR
Slit
Baffles
10um
Mg filter
aluminum MS-SXI snout
1/2" Pb
1/4"
Pb
1/2"
Cu
1/4"
Pb
TCC
Imaging
Slit

Figure 2

Figure 3 a

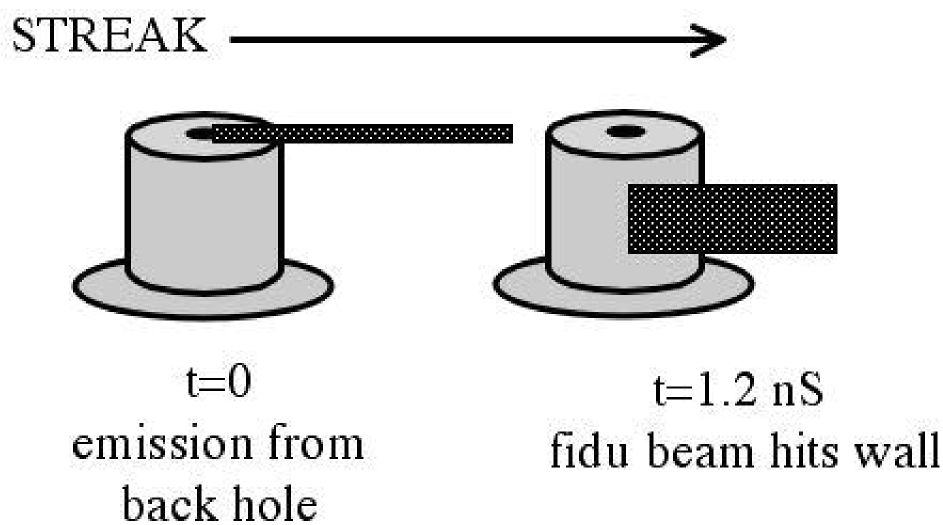
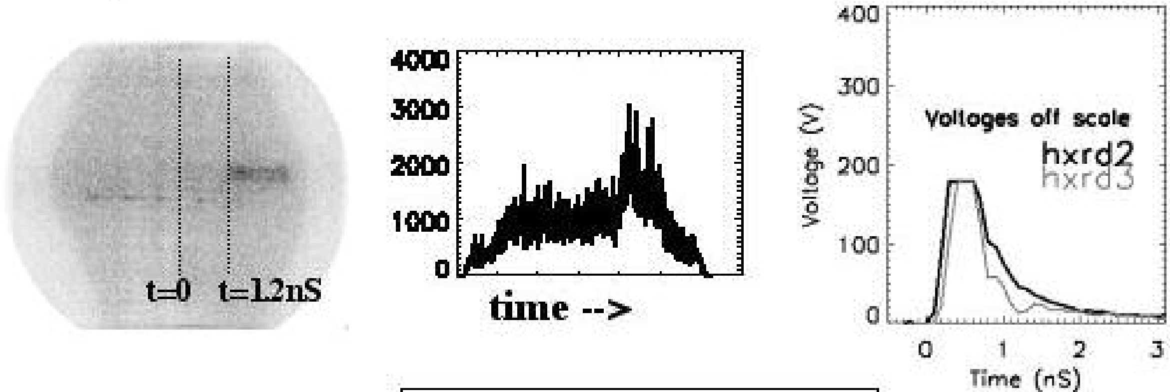
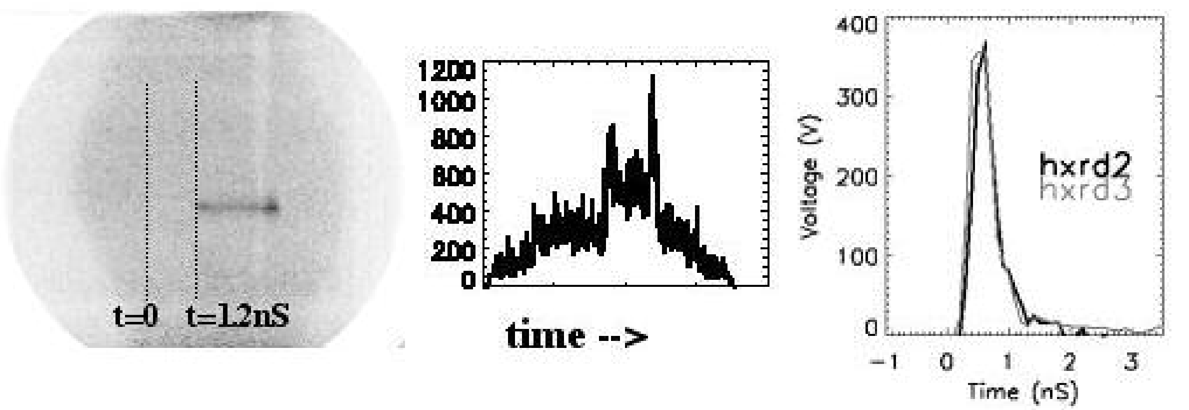


Figure 3a

b) Initial configuration; brass SSC slit

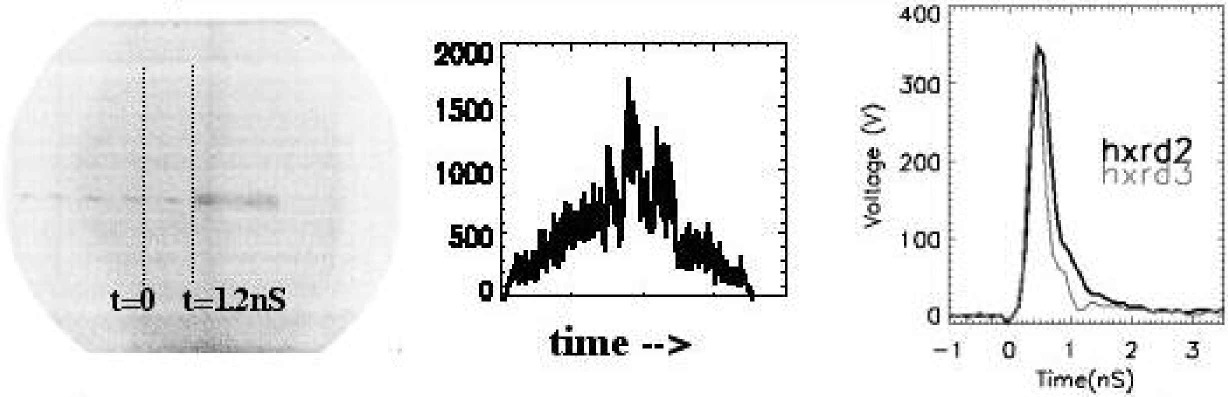


c) 1/2" Pb; Ta SSC slit

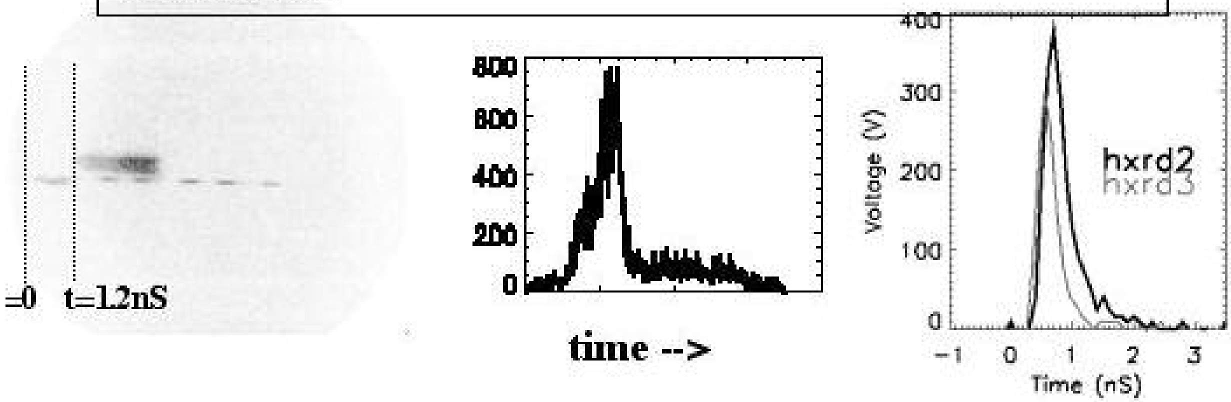


3

d) 1/4" Pb + 1/2" Cu +1/4" Pb; Ta SSC slit



e)1/8" Pb around SSC1 ; 1/4" Pb + 1/2" Cu +1/4" Pb;
Ta SSC slit



3

□

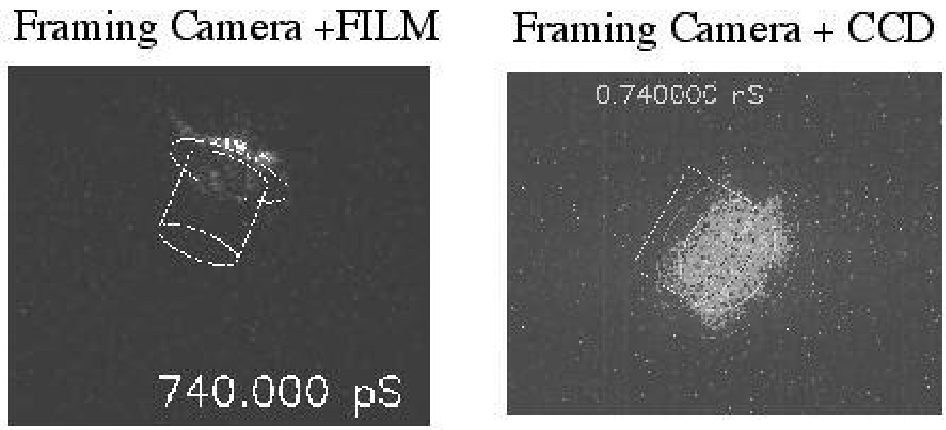


Figure 4

Above was paper for conference.

Following is the poster (paper had minor changes)

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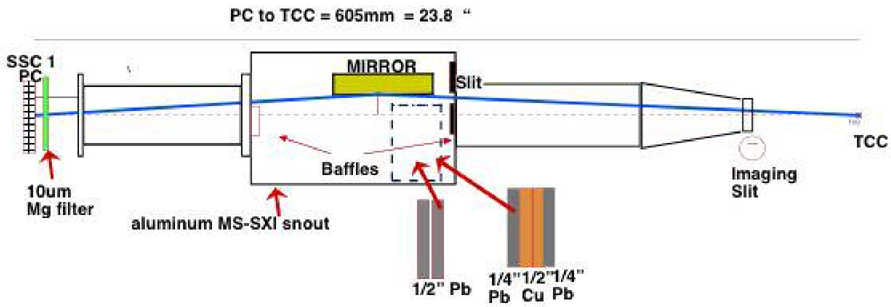

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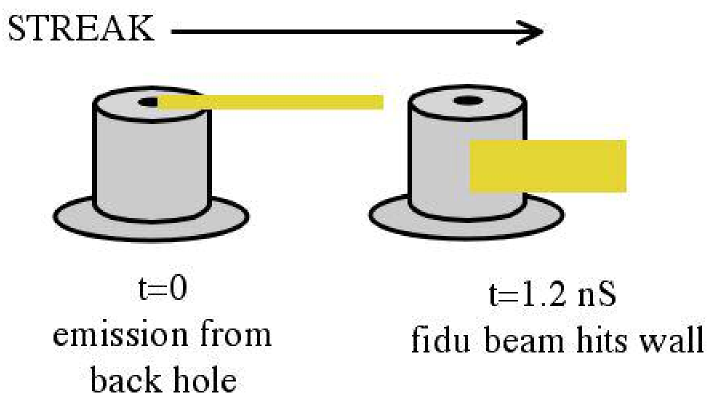
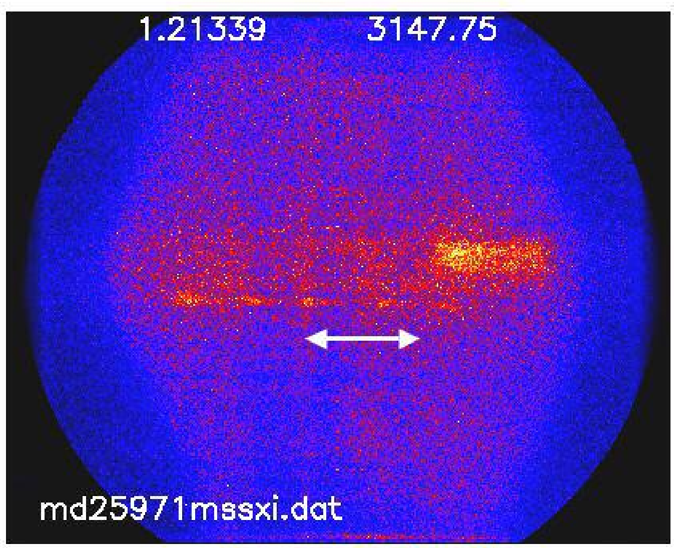
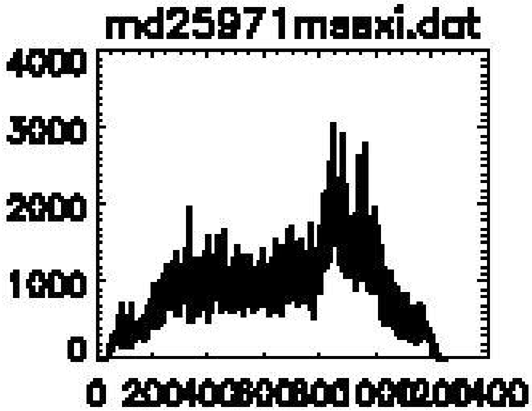
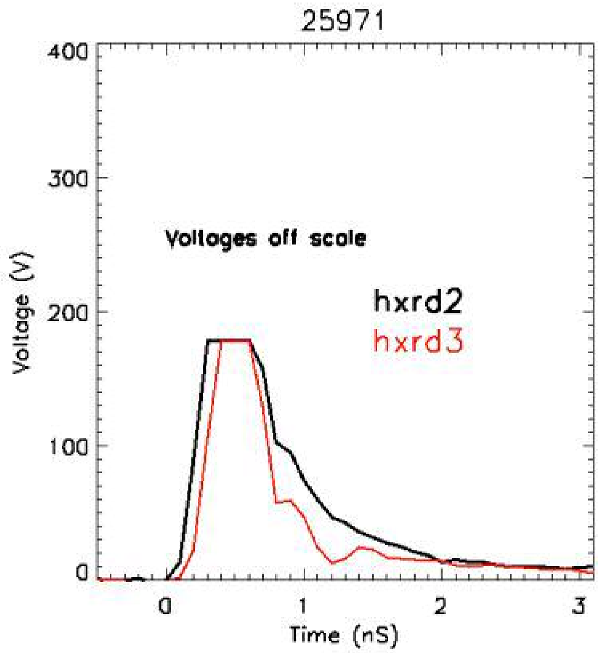


Figure 3a

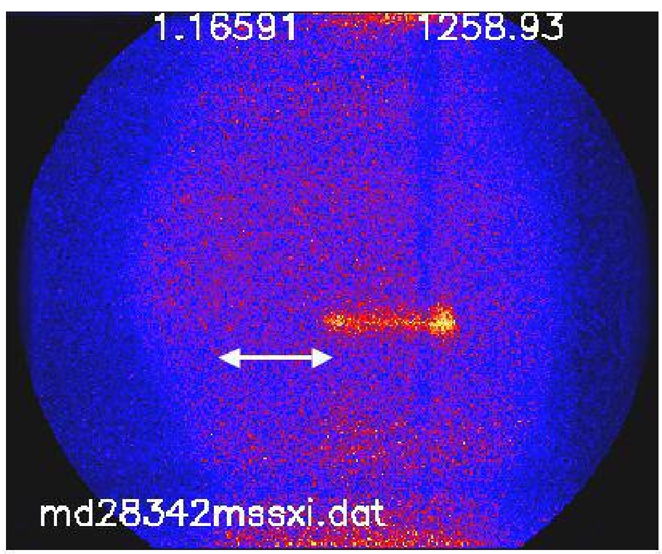
Initial configuration; brass SSC slit

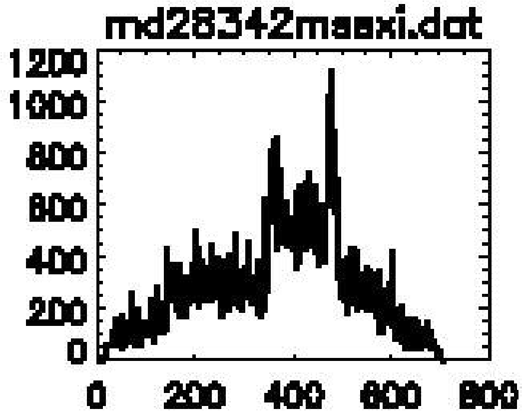


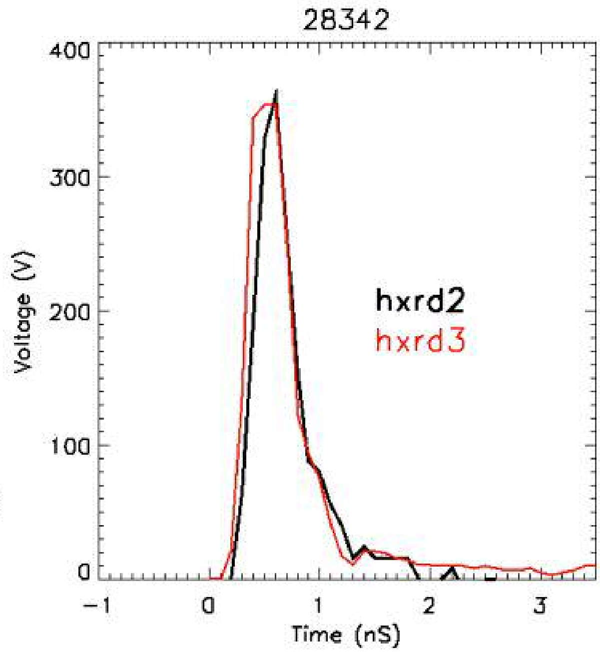




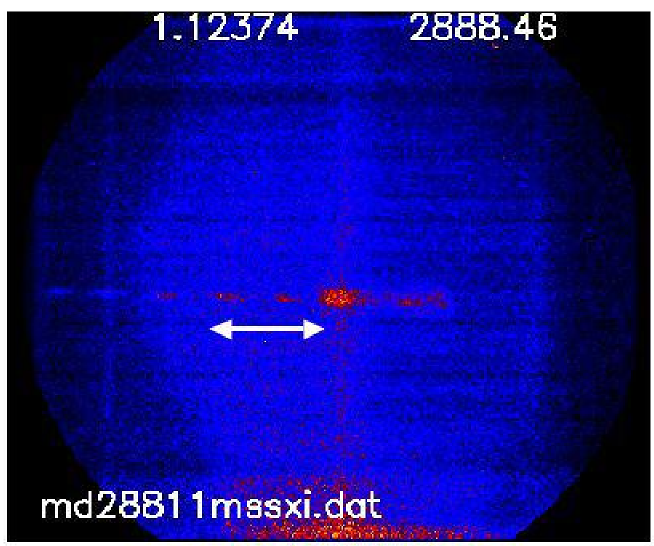
1/2" Pb; Ta SSC slit

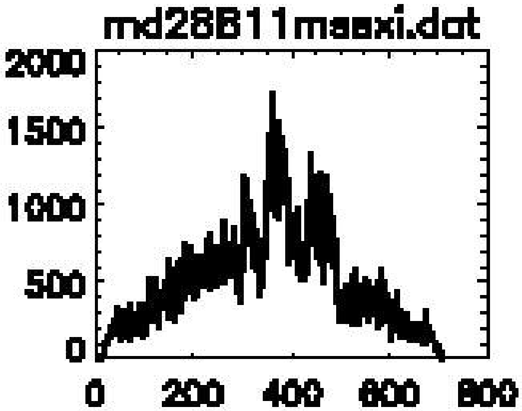


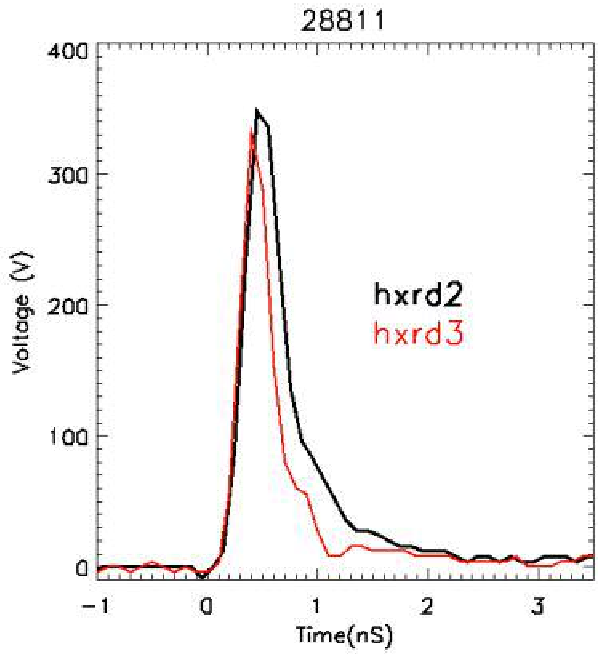




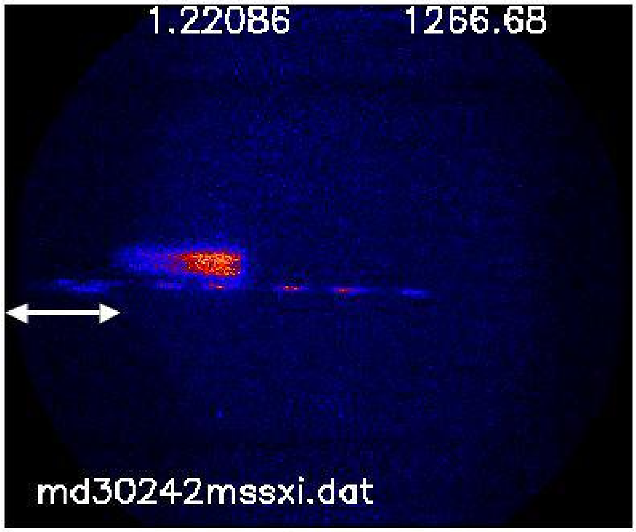
1/4" Pb + 1/2" Cu +1/4" Pb; Ta SSC slit



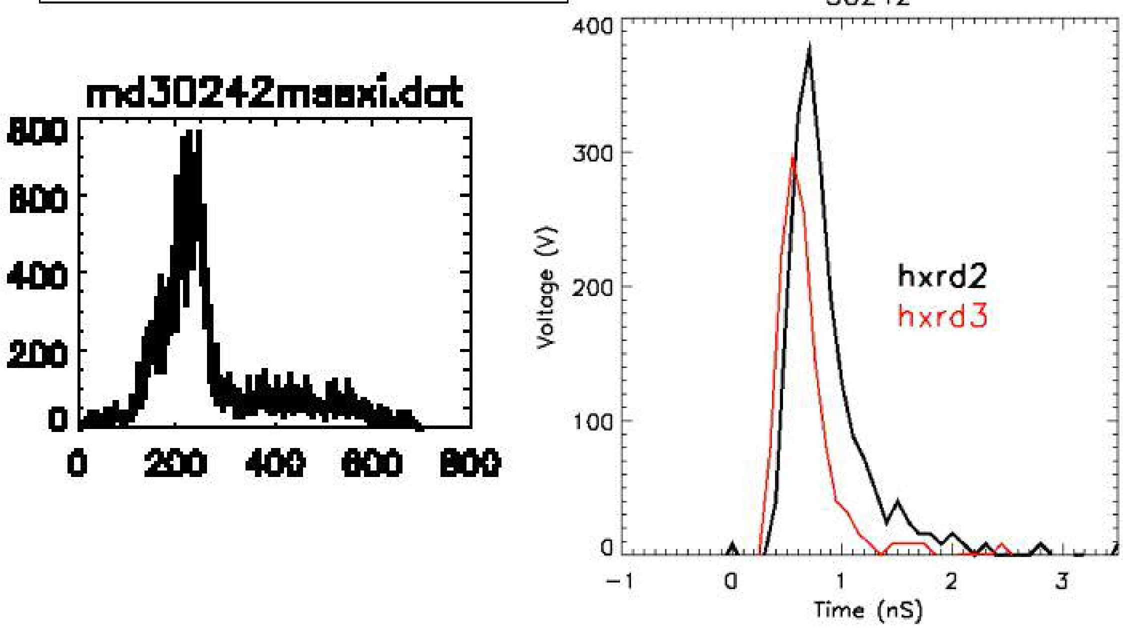




1/8" Pb around SSC1 ; 1/4" Pb + 1/2" Cu +1/4" Pb;



Ta SSC slit



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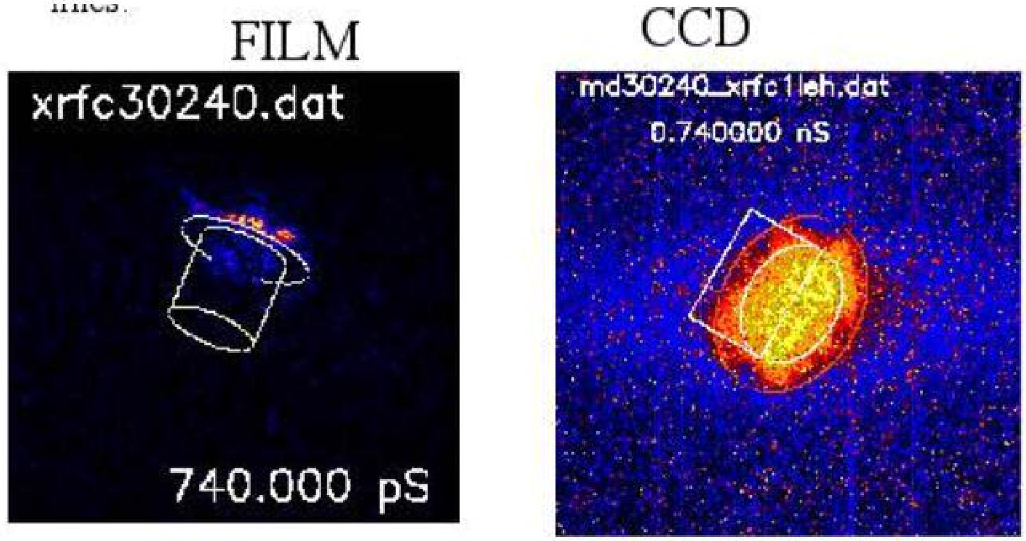
lines.



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